

DAM SAFETY INSPECTION REPORT

**PLAINWELL DAM NUMBER 1
ID #00491
SE 1/4 SEC 24. T1N, R12W
KALAMAZOO RIVER
ALLEGAN COUNTY**

OWNER: Michigan Department of Natural Resources

OPERATOR: Tyson Edwards
Allegan State Game Area
4590 118th Avenue
Allegan, Michigan

**HAZARD POTENTIAL
CLASSIFICATION:** High

INSPECTED BY: Michael W. Oakland, P.E.
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Detroit, Michigan

INSPECTION DATE: April 16, 2004

REPORT DATE: July 12, 2004

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INTRODUCTION

This report summarizes the results of a visual inspection of the Plainwell Dam on the Kalamazoo River in Plainwell, Michigan (Figure 1). The dam is being inspected as required by the Dam Safety regulations that stipulate high hazard potential dams be inspected every 3 years or 3 years following significant repairs. Repairs were made on the Plainwell dam during the winter and spring of 2001 to temporarily stabilize the dam in the anticipation that PCB contaminated sediments would be removed within 5 years allowing the complete removal of the dam. No substantial progress has been made with respect to the removal of the sediments, and thus, for the purposes of this report, it is assumed that the dam must meet the requirements of Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 PA 451. This report is limited to a visual investigation and review of previous inspection reports, plans, and data which are available. This report should not be considered as an in depth engineering investigation.

The visual inspection was made by Michael Oakland, Stephen Amrein and Todd King of Camp Dresser & McKee. Paul Bucholtz (Michigan Department of Environmental Quality), James Hayes (Dam Safety Unit for the Michigan Department of Environmental Quality) and John Lerg, Scott Hanshue, Tyson Edwards and Sara Schaefer (Department of Natural Resources) were also present. Conditions during the time of the visit were sunny with temperatures around 60 degrees Fahrenheit. The water level at the dam was relatively low with about 6 inches of water flowing over the spillway. The flow of water obscured the spillway surface and downstream apron.

CONCLUSIONS AND RECOMMENDATIONS

The Plainwell Dam is in poor condition and has inadequate spillway capacity. The dam is overgrown and has signs of erosion (see site sketches and photographs, Appendices A and B, respectively) in several locations due to overtopping as well as inadequate slope protection on the upstream face. The concrete continues to deteriorate in the areas where rough surfaces from the former partial demolition are exposed. Failure of the dam would have potential severe environmental impacts as contamination currently isolated in impoundment sediments would be mobilized and transported downstream.

If the Plainwell Dam is not to be removed in the very near future, the following recommended repairs should be completed as soon as possible. These repairs are listed by priority:

- Reconstruct the walls and embankment to enlarge the spillway capacity to meet current requirements. At the same time, the deteriorated concrete training walls at each side of the spillway and the interior piers should be repaired and surfaces protected against further deterioration.

- The entire left embankment should be re-graded, removing all trees and brush, and shaped with an even crest with upstream and downstream slopes no steeper than 3 horizontal to 1 vertical. Debris below the former powerhouse location should be excavated and replaced with low permeability fill which extend into the abutment to form an adequate cutoff to seepage. The upstream slope of the re-graded spillway should be protected by riprap with grass planted over the remainder of the spillway.
- The exposed right bank upstream of the spillway should be cutback and stabilized by riprap to avoid further loss of soil.
- Erosion on the downstream side of the right training wall should be filled and re-graded.
- Debris caught in the spillway and just upstream of the spillway should be removed.
- Cut brush on the left embankment near the former powerhouse should be removed.

PROJECT INFORMATION SECTION

The Plainwell Dam and associated powerhouse were constructed in 1902 as part of a hydroelectric facility. In 1908, the spillway failed and was rebuilt. The original powerhouse was destroyed by fire in May 1919 and was rebuilt in March 1921.

About 1965, the dam was decommissioned as a power generator and ownership of the dam was transferred from Consumers Power Company to the Michigan Department of Natural Resources (DNR). The DNR raised and jammed the spillway control gates in the open position at that time to lower the upstream impoundment to the fixed weir level. In 1986, DNR removed the powerhouse structure and some of the spillway about the fixed crest. At the same time, the embankment slopes adjacent to the spillway and powerhouse were cut back to an approximately 4 horizontal to 1 vertical slope.

The dam is approximately 1215 feet long. Looking downstream, the dam is comprised of a former concrete hydroelectric generation section to the far left, a left earthen section, a concrete fixed spillway, the former lift gates, and a right earthen section. The section lengths are approximately 72, 175, 40, 176, and 750 feet long, respectively. The elevation datum used in the previous inspection reports is the National Geodetic Vertical Datum (NGVD) (formally the USGS datum). Elevations mentioned in this report will be based on the NGVD.

No design drawings are available for the Plainwell Dam. However, based on descriptions in previous inspection reports and observations made during our site visit, it appears that the dam consisted of the following:

- A service spillway consisting of eight 20 feet wide lift gates with an additional 40 feet wide ogee spillway section. A buttress was constructed between each spillway section. The top of the ogee spillway section was set at elevation (El.) 706.0 with the sill of the lift gates at El. 702.5. The original buttress between the lift gates had a top at El. 715.5 and a walkway spanned the gates at El. 717.0. The spillway and sill was about 23 feet wide with an additional 12 feet of concrete apron. The top of the apron was at El. 696.5. The thickness of the concrete is not known, but is believed to be founded on the glacial deposits which underlie the area. A wall existed about 20 feet upstream of the fixed spillway parallel to the dam.
- A powerhouse near the left abutment formed the left portion of the dam with the top of the structure at El. 717.0. The powerhouse included three turbines with grates and raceways to each turbine. The powerhouse was approximately 31 feet wide and was founded in the glacial deposits which underlie the area. The lowest depth of the powerhouse is not known.
- A retaining wall extending from the right of the powerhouse to the spillway formed the upstream face of the embankment. The top of the wall was set at El. 714.0 and the earth embankment slopes gently downstream into a former island in the river. The slope is grass covered with some saplings and brush. Larger trees exist on the former island downstream of the dam. A shallow slope also exists upstream of the wall. The height and slope of the upstream slope varies and is also grass covered.
- A right embankment consisting of a long earthen embankment up to 12.5 feet in height with a crest at El. 715.5. A 5.5 feet high concrete wall formed the upstream side of the embankment. The embankment was constructed with a 3 horizontal to 1 vertical upstream slope and a 2 horizontal to 1 vertical downstream slope and a crest width of about 11 feet. A gravel road now exists on the embankment crest. The remaining embankment is grass covered with some small trees and brush along the embankment.

As part of the 1986 demolition, the powerhouse has been largely removed along with the spillway walls and buttresses to just above the level of the fixed spillway at about El. 707. A low area in the embankment is present at the site of the former powerhouse. The slopes in this area are approximately 4 horizontal to 1 vertical.

PRIOR INSPECTIONS

The dam was inspected in May 1979 as part of the Phase I inspection program administered by the Army Corps of Engineers. The Phase I inspection was conducted by Owen Ayres and Associates, Inc. The inspection was conducted prior to demolition of the gates and powerhouse.

Since the 1986 demolition, the dam has been inspected by the Dam Safety Unit in September 1993, August 1994 and September 1996. The 1996 inspection report by the DNR contained the following observations:

- Trees and brush were growing within the embankment between the powerhouse area and the spillway and on the right embankment. However, with the lowering of the pool level, the right embankment is essentially above impoundment level.
- The left training wall of the spillway has two large vertical cracks and several smaller cracks. However, none of the cracks were separated or showed signs of differential movement.
- Erosion is evident along embankment areas cut as part of the demolition. The erosion is considered due to flood water overtopping the dam.

The dam was inspected again in November 1998 by CDM for purposes of assessing interim repairs required to maintain the stability of the dam over the next 5 to 10 years during removal of PCB contaminated sediments upstream of the dam to allow for the dam removal. The inspection recommended that the spillway capacity be increased by lowering a section of the fixed crest ogee spillway, installation of a cutoff wall to reduce seepage through the powerhouse foundation and grouted riprap to be added in an eroded area frequently overtopped. This work was completed in the spring of 2001 and periodic inspections approximately every 6 months have been conducted since that time to assess the interim condition of the dams.

FIELD INSPECTION

Observations at the time of the site visit are summarized as follows:

- In general, the left embankment is very uneven with a low area at the former powerhouse, rising to a high area in the vicinity of the former island and then dropping back down to a cut slope adjacent to the left training wall of the spillway. The embankment generally appears stable other than sloughing on the upstream slope near the training wall. No lateral movement or tipping of the training walls was observed. The long embankment on the right side of the dam is reportedly no longer necessary due to the lower spillway height, however it too appears generally stable with no movement to the concrete wall which forms the upstream face along much of the embankment.
- The left embankment of the dam has areas overgrown by brush and trees.
- The upstream slope of the embankment near the left training wall is very steep and is eroded at the toe.

- The left embankment does not have adequate erosion protection on the upstream slope and erosion is also present on the downstream slope around the edges of the grouted riprap placed adjacent to the left training wall.
- At least one rodent hole was found on the downstream slope of the embankment.
- The area around the former powerhouse is low and continues to be an area overtopped during storm events. While not leaking at the time of this visit, recent visits during higher pool conditions have shown leakage through the embankment at the former powerhouse location and through the left abutment. Continuing uncontrolled leakage could cause internal erosion of the embankment, ultimately leading to dam failure. An eroded pathway exists on the downstream slope in this area. Cut brush has also be left on the embankment in this area.
- The left spillway training wall is spalled in areas with two large cracks on the upstream end. While the piers where inaccessible and prevented detailed inspection, it was evident that these partially demolished structures were also deteriorated. The piers where also overgrown.
- Debris was caught on the spillway which included a large log. A timber cribbing mat was also caught on something, possibly an old intake, just upstream of the spillway.
- The bank along the right side of the stream has several recent sloughs. The area behind the right training wall is eroded with a gully about 1 foot deep.

It was not possible to confirm the condition of the downstream apron, stream bed below the apron or spillway buttresses. However, from what could be observed, no signs of instability are apparent. Based on the portions of the dam observed, it appears that the dam embankments and remaining spillway are generally stable. However continued overtopping of the unprotected portions of the embankments could result in further erosion.

STRUCTURAL STABILITY

Conditions at the dam do not pose an immediate structural threat. The dam embankments, walls and spillway appear to have adequate stability against sliding or slope failure. However, long term continued loss due to erosion during overtopping and sloughing of the upstream slope and right stream bank will result in possible future instability.

Similarly, continued deterioration of the concrete forming the piers and training walls, will result in loss of stability of the spillway structure.

HYDROLOGY AND HYDRAULICS

Prior to the recent modifications to lower the fixed crest ogee spillway, the previous inspection report noted that the design discharge for the spillway is the 0.5 percent chance flood discharge of 11,000 cubic feet per second (cfs) which would have resulted in a flood stage at about El. 709.1 at the dam which is about 2.1 feet above the top of the spillway abutments and the current embankment grade at the former powerhouse. The capacity of the spillway at that time with a flood stage at the top of the spillway abutment walls was 5700 cfs which is approximately equal to the estimated 10 percent flood.

The recent modifications to the spillway have reduced the overtopping during the design flood to about 1.6 feet which proportionally increases the existing spillway capacity to about 7720 cfs.

The spillway capacity is still less than required to meet the design storm requirements resulting in flow over the low areas of the dam. In particular, this excess flow is over the former powerhouse area of the left embankment and at slightly higher stages, over embankment areas immediately behind the left and right training walls.

Currently, each of the overflow areas has limited erosion protection consisting of vegetation cover, loose riprap and grouted riprap in the downstream area of the area behind the left training wall. This erosion protection is considered to be inadequate for the frequency of the overtoppings. The spillway capacity must be increased to the design storm condition.

OPERATION AND MAINTENANCE

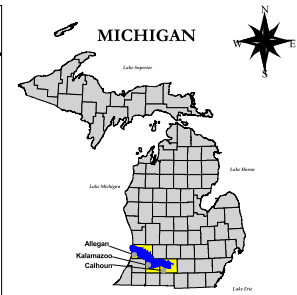
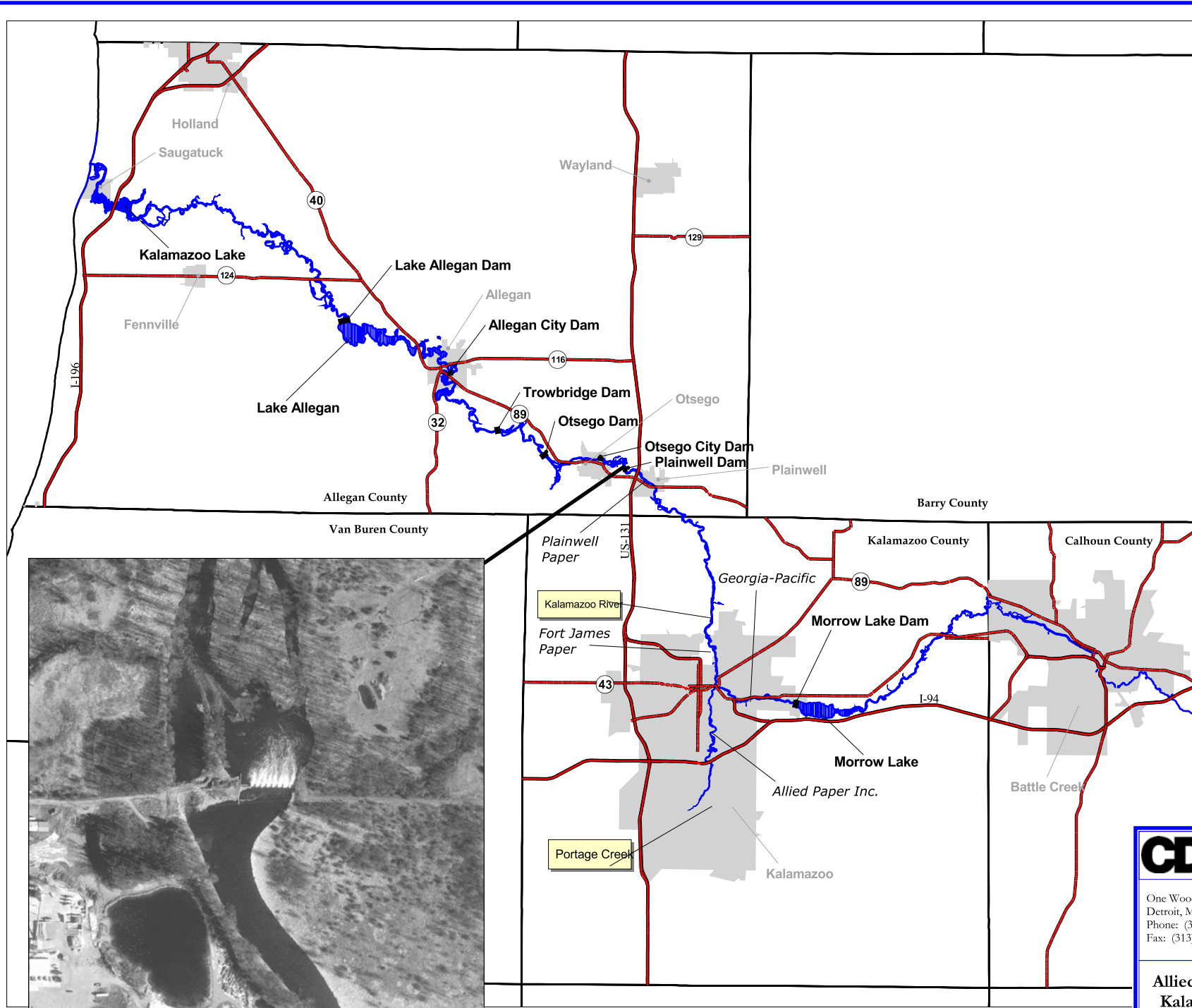
Operation of the dam is by Wildlife Division staff from the Allegan State Game Area. According to MDEQ and MDNR staff, a written operation and maintenance (O&M) plan has been developed for the dam and is on file with the Dam Safety Unit.

EMERGENCY ACTION PLAN

According to MDEQ and MDNR staff, an emergency action plan (EAP) has been prepared for this facility. A copy is on file with the Dam Safety Unit and with appropriate DNR offices. This EAP should be reviewed annually and updated as necessary.

APPENDIX

A sketch of the observations made at the time of the visit (Appendix A) and photographs from this inspection (Appendix B) are attached.

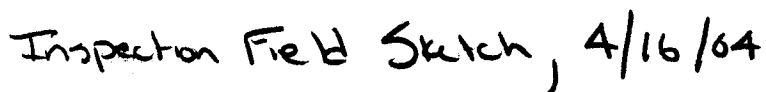


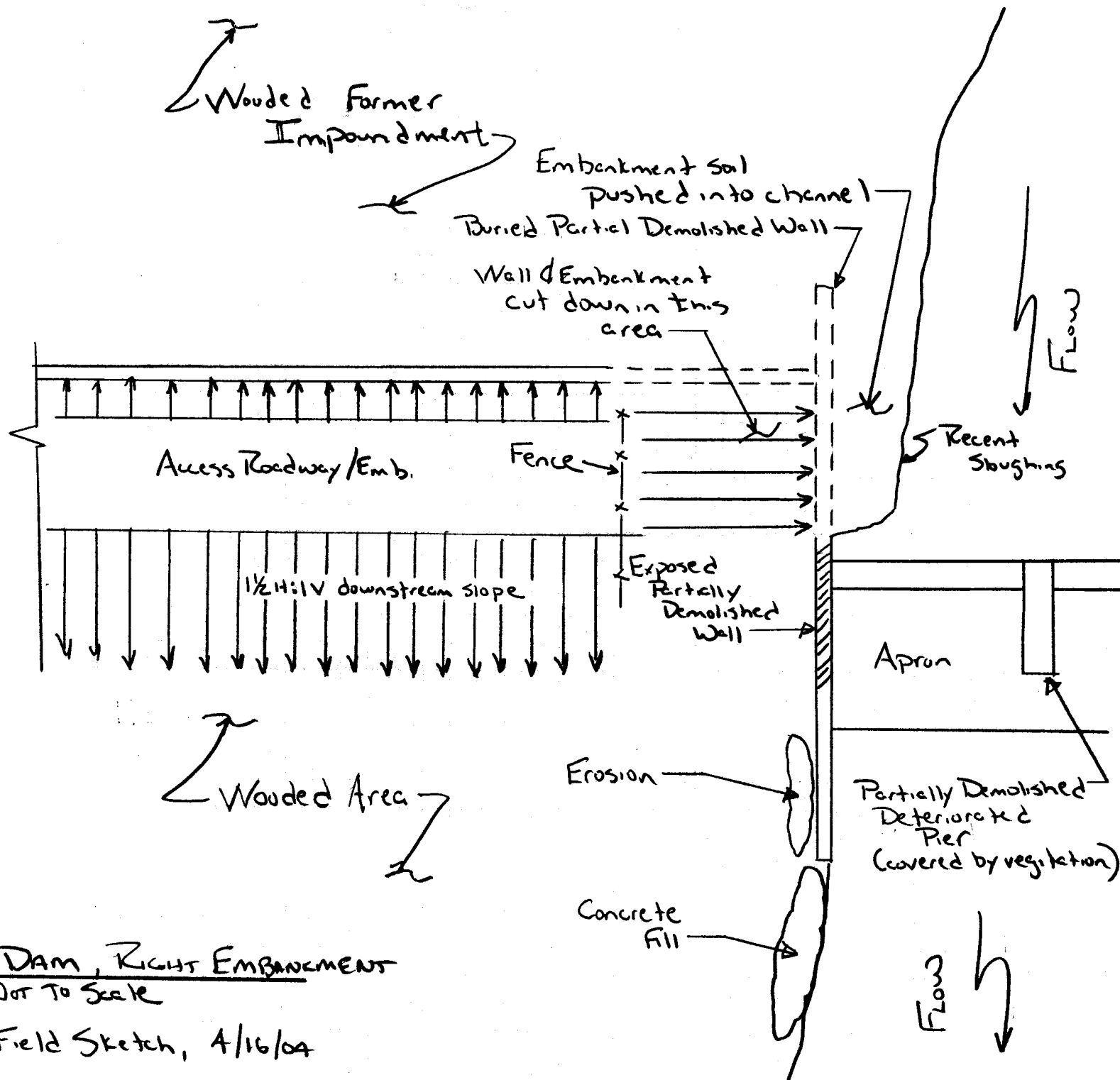
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One Woodward Ave., Suite 1500 Detroit, Michigan 48226 Phone: (313) 963-1313 Fax: (313) 963-3130	Prepared By: A. Santini Updated: 6/11/04
Allied Paper, Inc./Portage Creek/ Kalamazoo River Superfund Site	
Overall Site Map Plainwell Dam	Figure No. 1

Site Sketches

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Appendix A





RAINWELL DAM, RIGHT EMBANKMENT
NOT TO SCALE

Inspection Field Sketch, 4/16/04

Site Photographs

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Appendix B

Plainwell Dam – Right Side



Right Training Wall with Sloughing Streambank behind



Spillway Piers

Plainwell Dam - Right Side



Partially Demolished Deteriorated Concrete at Right Training Wall

Plainwell Dam - Left Side



Deteriorated Piers



Stump and Brush on Downstream Embankment

Plainwell Dam - Left Side



Eroded Grouted Riprap



Deteriorated Piers with Vegetation and Log caught on Spillway

Plainwell Dam - Left Side



Erosion Path on Downstream Slope



Ungraded, Sloughing Upstream Slope with no Erosion Protection

Plainwell Dam - Left Side



Crack in Left Training Wall